DEVELOPMENT OF AN ASSESSMENT TOOL FOR POSITIVE EXPERIENCES ABOUT SCIENCE (PES)

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Abstract

This research aimed to develop an assessment tool for students' Positive Experiences about Science (PES). A preliminary version of PSE was developed through literature review, consisting of academic emotion, self-concept, learning motivation, career aspiration, and attitude in science. A pilot test was conducted with 198 students and a main test was then conducted with 1,841 students. The PES test found to have good validity and reliability. There were significant ($p<.05$) differences by students' grade, gender, and participation in science activities.
Keywords: *positive experiences about science (PES), science academic emotion, science-related self-concept, science-related motivation*.

Introduction

Traditionally, students' cognitive achievements have been considered as major goals in science teaching and learning in schools. However, affective aspects such as students' learning motivation, beliefs, and attitudes became an important educational goal due to the influence in students' career aspiration and academic professions in society as well as the quality of personal life (National Research Council, 2011). Although students in Korea have achieved higher cognitive achievements in science than international average in PISA and TIMSS, affective achievements in science have been the lowest among the participating countries (Choe, et al., 2013). Improvement of affective achievements in science became an urgent agenda in Korea.

When a national science curriculum in Korea was revised in 2015, the positive experiences about science (PES) became an important aspect as the 2015 revised national science curriculum is more competency–based (rather than subject domain-based) and more emphasizing student-driven activities and process-based (rather than out-

come-based) assessments in schools (MOE, 2016). Characteristics of affective achievements can be a driving force that helps students lead self-directed, engage happily, and not give up easily even when faced with difficulties in science learning. In addition, students' emotional experiences such as enjoyment and interests in science learning situations can help them sustain reasonable and scientific attitudes in everyday life and career decision situations. Students' affective achievements in science are considered as important as cognitive achievements in Korea.

However, assessment tools and standards to evaluate students' affective achievements are still limited. It was needed to have more research on teaching and learning strategies and evaluation methods to enhance students' positive experiences about science. It was necessary to identify the students' affective characteristics influencing PES and indicators to evaluate students' affective achievements in science. Therefore, the aim of this research was to explore the components of students' positive experiences about science and develop and validate reliable assessment tools to evaluate students' affective achievements in science.

Research Methodology

Participants

Participants for the pilot research consisted of 198 students (95 female; 48.0%) including 53 4th, 43 6th, 39 8th and 63 10th graders. The main test to establish reliability and validity was administered to 1,841 students (892 female; 48.5%) who were sampled from 947 schools of elementary (grades 1-6), middle (grades 7-9), and high (grades 10-12) schools nationwide.

Table 1. Demographic information of research participants.

School level	Grade level	Pilot test			Main test		
		Male students	Female students	Total	Male students	Female students	Total
Elementary	4th	29 (14.6)	24 (12.1)	53 (26.8)	212 (11.5)	184 (10.0)	386 (21.5)
	6th	25 (12.6)	18 (9.1)	43 (21.7)	202 (11.0)	196 (10.7)	399 (21.7)
Middle	8th	19 (9.6)	20 (10.1)	39 (19.6)	248 (13.5)	242 (13.1)	490 (26.6)
High	10th	30 (15.2)	33 (16.7)	63 (31.8)	287 (15.6)	269 (14.6)	556 (30.2)
	Total	103 (52.0)	95 (48.0)	198 (100.0)	949 (51.5)	892 (48.5)	1,841 (100.0)

Test Items Generation

A review of the literature suggested that characteristics of positive experiences about science (PES) include five components of science academic emotion, science related self-concept, science learning motivation, science related career aspiration, and science related attitude. After two times of Delphi survey with science educators, PES assessment tool was established with 35 items of a four-point Likert scale of potential responses, very often = 4 (very positive), often = 3 (positive), sometimes = 2 (negative), and never = 1 (very negative).

Data Collection and Analysis

Data were collected during October 2016 by online survey. Respondents to instrument took about ten minutes in average to complete the tool. Raw data were gathered in excel program and statistical analysis was performed with SPSS 18.0 for descriptive statistics, reliability test, confirmatory factor analysis, one-way ANOVA, and t-test.

Research Results

Reliability

Five indicators domains of a final PES assessment tool are shown in Table 2. The values by domain and the total standardized values are calculated by taking into account the mean and standard deviation of each domain. Four levels of PES index are level 1-very positive (more than 60.01), level 2-postive (50.01~60.00), level 3-negative (40.01~50.00), and level 4-very negative (less than 40.00). Cronbach α for the tool appeared as 0.963 for 35 items with range between 0.861 and 0.908, indicating good reliability. Fitness of five factor model by confirmatory factor analysis shows X^2=6359.617 (df=550; p<.05), CFI=.859, TLI=.870, RMSEA=.076, indicating fairly good model (good acceptance level: CFI, TLI> 0.8; RMSEA: 0.05~0.08).

Table 2. Five indicator domains of PES assessment tool and its reliability.

Indicator domain (#)	Operational definition	Subcomponents (# of items)	Reliability
science learning emotion (6 items)	Various emotional features that have been shown to influence science learning	Positive learning emotion (3); Negative learning emotion (3)	.861
science related self-concept (6 items)	Thoughts and confidence that students have about themselves in science learning	Self-efficacy (3); Self-esteem (3)	.900
Science learning motivation (10 items)	State of mind or will to study a specific task in science learning	Willingness (2); Participation (2); Attention (2); Relevance (2); Goal orientation (2)	.872
Science related career aspiration (5 items)	Motivation or will to choose and maintain science, engineering, technology related career path	Career recognition (1); Career value (2); Career interest (1); Career will (1)	.895
Science related attitude (8 items)	Perception and recognition of the role of science and scientists, curiosity and interest in science, awareness of the value of science	Value of science (3); Perception of science (3); Interest in science (2)	.908
Total	35 items		.963

Differences by Grade Level

It appeared that the PES scores significantly ($p<.0001$) decreased from grade 4th to grade 10th (see Table 3). Elementary students had higher PES scores than those of middle and high schools, while there were no significant differences between middle and high school students.

Table 3. Differences of PES assessment test scores by grade level.

Grade	4th (*n*=386)	6th (*n*=399)	8th (*n*=490)	10th (*n*=556)	*F*	*p*
mean ±SD	53.1±9.0 ^{a}	50.7±9.8 ^{b}	49.0 ^{c}	48.3 ^{c}	22.0	.0001

* Different small letters (a, b, c) at the upper corner of statistical values indicate significant differences in groups.

Differences by Gender

It appeared that PES scores were significantly ($p<.0001$) higher in male students than female students (see Table 4). Male students perceive science learning more positively than female students. This result was similar to previous international studies of Debacker & Nelson (2000), George (2006), and Weingburgh (1995).

Table 4. Differences of PES assessment test scores by gender.

Gender	Male students (*n*=949)	Female students (*n*=892)	*t*	*p*
Mean ±SD	51.4±10.2	48.5±9.5	6.44	.0001

Differences by Participation in Science Related Extracurricular Activities

It appeared that PES scores by students with participation in science related extracurricular activities were significantly (p<.0001) higher than those without participations (see Table 5).

Table 5. Differences of PES scores by students' participation in science related extracurricular activities.

Category	Students with participation (*n*=1,012)	Students without participation (*n*=768)	*t*	*p*
mean ±SD	52.0±9.9	47.7±9.6	9.13	.000l

Conclusions and Implications

A PES assessment tool was found to have a good validity as well as reliability. There are statistically significant differences in the norm distribution and scores of PES assessment test by grade level, gender, and participation in science related extracurricular activities. It is important to pay more attention to improve instructional strategies as well as science education policies for middle and high school students and female students to have positive experiences about science. It also implies that instructional strategies and science education policies can function as a parameter of effectiveness in enhancing students' affective achievements in science. However, the PES assessment tool is newly developed and currently administered in Korea. It may be promising to use in other countries to draw implications as international comparative studies.

References

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Appendix

Assessment Tool for Positive Experiences about Science (PES).

A. Emotion in Science Learning	C8. The contents learning in science class can be used in my daily life.
A1. I enjoyed science class.	C9. It is important for me to understand in science class.
A2. I was satisfied with science class.	C10. It is important for me to successfully accomplish
A3. Science class was interesting.	tasks and activities in science class.
A4. Science class was boring.	D. Science related Career Aspiration
A5. Science class was annoying or troublesome.	D1. I learned about science related jobs.
A6. I was nervous or frustrated in science class.	D2. I think science-related jobs give me an opportunity
B. Self-concepts in Science learning	to learn and develop on my own.
B1. I can solve tasks and activities given in science class very well.	D3. Science-related jobs have a great impact on our society.
B2. It is easy for me to study science.	D4. I became interested in science-related jobs.
B3. Science is one of my favorite subjects.	D5. I want to have a science-related career in future.
B4. I am recognized by teachers and friends in science class.	E. Science-related Attitudes
B5. Through science class, I feel like I am important person.	E1. Science helps make this world a better place to live.
B6. Science class makes me to be satisfied with myself.	E2. Science is worth studying.
C. Motivation in Science Learning	E3. Science is useful even after school graduation.
C1. I try to do my best in science class.	E4. Science development has influenced on development
C2. I spend a lot of time studying science.	of environment, technology, and society and vice verse.
C3. I participate actively in science class.	E5. It is desirable to increase time for science class.
C4. I ask many questions especially in science class.	E6. Scientists think and judge reasonably and logically.
C5. I concentrate on my science class and not being distracted.	E7. I want to know more about science.
C6. I often think of something else not related to science class.	E8. I like science-related experiences (reading, field
C7. What I learned in science class is relevant to me.	trips, watching science videos, etc.).